NEW PREFABRICATED ELEMENTS
OF LIGHTENED PLASTER USED FOR
PARTITIONS AND EXTRADOS

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ABSTRACT

Several types of prefabricated elements for partitions and extrados are presented, which improve the similar systems presently in the market. These elements can be classified in two well defined groups. The first group is formed by lightened plaster panels for partitions of dimensions 60 x 265 cm (width, height) and of 7 and 10 thickness. In the second group, panels for extrados with the same dimensions are included but with a thickness of 9,5 and 5 cm, including the 3 cm thickness of the incorporated high density expanded polyestirene sheet. The 9,5 cm, panel as well as the panels for partitions have an inner air chamber within the rigidizing ribs, to allow the installation of services.

Key words: Plaster panels; gypsum panels; partitions; extrados; prefabricated elements; lightened plaster.
MAIN TEXT

Introduction: There are two types of prefabricated systems for plaster partitions in the market. On the one hand there is the “bricklayer system” derived from the work done by bricklayers and plaster-cladders, it is a system with a deep rooted tradition in Spain. On the other hand there is the “carpenter system”, derived from the way carpenters work, this system, has a greater tradition in countries like the U.S.A, France, Germany, etc. The panels presented in this paper are the ones following the “bricklayer system”.

Prefabricated plaster partitions from the “bricklayer system”: In this system the elements used by the bricklayers, be they simple hollow brick or double hollow brick, or bigger ones such as air bricks are substituted by small dimension planks, generally 66x50 cm, also called plaster blocks and by floor to ceiling panels made of plaster basically which are received with a gypsum or plaster based adhesives. They are usually one leaf solutions, except for the special cases like in partitions with technical blocks. In Spain due to the fact that there is gypsum all over the country, many companies have been developed which are in the business of commerсing this type of systems.

The major advantages of these partitions as opposed to the traditional ones are: the bricklayers and plaster-cladders tradition deeply rooted in our country is maintained although with some changes, it does not need specially skilled labourers to place it, the output of the labourers is improved, therefore this compound unit reduces cost prices, its construction systems are without mortar. The compound unit, is left completely finished with the received panels or planks only to be finally decorated (paint, wallpaper, etc). Because the pieces are manufactured in a workshop, one can obtain greatly planed surfaces using finishes with a minimum coating capacity (slick paint, etc).

The major drawbacks are: the greater the floor to ceiling elements, the greater their unit-per-surface weights, this leads to more damages and fractures in the transportation and installation. Evenmore since the system has less joints per square metre, it is more rigid, therefore, it has a poor adjustment to the deformations of the adjacent structural elements. Due to the density difference between the receiving adhesives and the planks, the so called “televion effect” (marks on the different joints) can take place especially in the floor to ceiling panels.

We consider the second of the two options presented of the “bricklayer system” the most adequate one, that is floor to ceiling panels, since they offer greater possibilities to be prefabricated. The floor to ceiling panels presently in the market are made of a gypsum base with a minimum glass fiber strengthenner, and are provided with vertical perforations with a circular section, in order to lighten the weight as well as to allow the installation of services in the inside of the panel. The binding among the panels is solved with a gypsum adhesive and a groove and tongue joint. The dimensions of the panel are: T-7 2900x620x70 mm; T-9 2900x500x90 mm.
Justification of the design of the new panels: Once the drawbacks of the systems of floor to ceiling panels have been analyzed, the following actions are to be performed on the design to prevent those drawbacks:

1º A reduction in weight, this is achieved with the base material of the panels, that is lightened plaster.

2º Obtaining a similar mechanical resistance to the ones of the prefabricated elements presently in the market, but improving the deformation capacity of the whole. This is achieved with the base material for its fabrication.

3º An improvement of the acoustic insulation offered by the partition elements already in the market in order to obtain an acoustic partition. So as to achieve this, we will work with the asymmetric geometry of the panels and also with the advantage of the acoustic insulation capacity of the material being used.

Actions followed towards the geometry of the panels: The panels have an asymmetrical shape and are formed by two planks with different thickness joined together through the rigidizing ribs made of a flexible material (lightened plaster) to take advantage of the double wall (wall-spring-wall) of a different thickness. The superficial finish of the internal faces of the panel, which constitute the intermediate chamber, is let rough to allow a greater sound wave absorption not needing a special absorbent material inside to perform this function.

Keeping this mind, the following elements are proposed:

Figure 1 Type panel for partitions with a 10 cm thickness.

A horizontal section of an interior partition panel is presented with a dimensions 265x60x10 cm, in which A is a floating skin of fine plaster of thickness 2 mm, made with a flat mold, B is a lightened plaster plank, faced opposed to the rough plaster of thickness 3,5 and 2 cm, respectively (floating included) and C is an air chamber between the planks.

The planks are joined together with 4,5x2 cm, ribs, this allows an intermediate chamber of thickness 4,5 for the services, the binding of the ribs with the planks is done through gypsum-adhesive.
A horizontal section of a panel similar to the previous one is presented, but with a 7 cm, total thickness. It is formed by two equal planks, 2 cm each, and 3x2 cm, ribs which allow an intermediate chamber of 3 cm. The ribs are 265x3x2 cm.

A horizontal section of an extrados panel is presented, with dimensions 265x60x9.5 cm, forming a 3.5 cm, thick plank of lightened plaster (B) floated on its outside side and rough in the extrados (A), and a plank of expanded polystyrene of thickness 3 cm (E) joined to the lightened plaster, leaving an air chamber for the services (C). The binding of the ribs and the planks is done with gypsum-adhesive, and is joint with the expanded polystyrene is carried out with adhesive.

A horizontal section of an extrados panel is presented with a total thickness of 5 cm, composed by a lightened plaster plank floated on one side (1+2) 2cm thick
and an expanded polyestirene plank 3 cm, thick (E), joined directly to the lightened plaster plank by an adhesive.

**Tests performed on the lightened plaster panels:** Mechanical strength tests and tests for determining the physical properties are performed on fragments of lightened plaster panels made in laboratory and on similar sized fragments of the plaster panels in the market.

**Table 1. Average results of the tests performed on the panels.**

<table>
<thead>
<tr>
<th>Panel</th>
<th>Dimensions (cm)</th>
<th>Weight (g)</th>
<th>Unit density (g/cm)²</th>
<th>Shore C</th>
<th>Compressive strength (kp/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster</td>
<td>14x15x8</td>
<td>1532.3</td>
<td>0.91</td>
<td>65</td>
<td>43.75</td>
</tr>
<tr>
<td>Honeycombed plaster</td>
<td>14x15x9</td>
<td>1176</td>
<td>0.62</td>
<td>55</td>
<td>29.36</td>
</tr>
<tr>
<td>Lightened plaster</td>
<td>23x15.5x10</td>
<td>1455</td>
<td>0.40</td>
<td>85</td>
<td>17</td>
</tr>
</tbody>
</table>

**Physical tests:** It is important to underline the great reduction of the unit density in relation to the plaster units already in the market, as well as to remark the important superficial hardness value, since the external face is a floating skin with a low A/E proportion.

**Compressive strength tests:** The weight supported up to breakage in the lightened plaster panel, when the compression test is performed, is quite lower than the load supported by the other elements. Nevertheless, the deformation is far greater and is locally produced in the places where the pressure has been practised.

As a conclusion to this test, we can point out that the lightened plaster panel is perfectly adapted to the expected structural deformations, and in the case of them being produced, the result is the following:

1. On the one hand the floating skin on the joining area with the structure announces the process through the presence of small cracks, before fracturing, allowing the problem to be solved at the beginning.
2. Once the fracture is produced, since the web of the panel is kept stable, all its needs for the problem to be solved is scraping the cracked area and a new floating skin.
3. One can be sure that the deformation does not affect the rest of the panel, and so it will maintain its structure and finishes untouched.

**Test of hanging resistance:** A not-standarized test of hanging resistance was performed on the different elements, obtaining the following data; 1⁰. Load value

**Table 2. Average results of the hanging resistance tests performed on the panels.**

<table>
<thead>
<tr>
<th>Panel</th>
<th>Dimensions (cm)</th>
<th>25 k</th>
<th>40 k</th>
<th>50 k</th>
<th>55 k</th>
<th>60 k</th>
<th>65 k</th>
<th>70 k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster</td>
<td>14x15x8</td>
<td>si</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeycombed plaster</td>
<td>14x15x9</td>
<td>si</td>
<td>P1</td>
<td>gira</td>
<td>gira</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightened plaster</td>
<td>23x15.5x10</td>
<td>si</td>
<td>si</td>
<td>P1</td>
<td>gira</td>
<td>gira</td>
<td>gira</td>
<td>P2</td>
</tr>
</tbody>
</table>
when the plug starts turning (P1) and 2°. Load value when the plug detaches itself from the plank (P2). The results obtained with this test are:

As a result from the outcomes obtained, the great deformation capacity of the lightened plaster is confirmed, because as opposed to the other plaster planks which break and the plug comes off, the lightened plaster is deformed in such a way that the plug remains embedded inside the material with a lot heavier loads.

**Test of an environmental sound insulation:** A non standarized test of environmental sound insulation is performed on the different similar sized fragments of the plaster panels to be analyzed.

All the tests are performed in the same conditions:
- The sound source is constant and has a value of 81 dB (A).
- The sound measurements are tested with a soundmeter.
  - Lightened plaster panel 10 cm . . . . . . . sound insulation obtained 16 dB (A)
  - Lightened plaster panel 7 cm . . . . . . . sound insulation obtained 9 dB (A)
  - Honeycombed plaster panel 9 cm . . . . sound insulation obtained 9 dB (A)
  - Solid plaster block 9 cm . . . . . . . . . . .sound insulation obtained 6 dB (A)

From the results obtained we can conclude that although the lightened plaster panel mass is smaller, it greatly surpasses the results obtained for the similar elements presently in the market.

**CONCLUSIONS:**

The great possibilities that these products could have in the market of the prefabricated elements for partitions and extrados made of a plaster base have been proved, the following improvements have been achieved in relation to other similar elements nowadays commercialized:

- **Considerable reduction of the weight/m of the panel:** This means in terms a greater output in the site placing and less fractures in the transportation and handling of the panels to its definite situation.

- **Improvement of the deformation capacity of the system,** as shown by the mechanical tests. This will prevent the partition to support structural loads due to the deformation of adjacent structural materials. The direct consequence is that the deformation is not concentrated at the joints, and does not crack here, as it is the norm in the systems made presently.

- **Improvement of the sound insulation,** due to the panel design. This design is absolutely new in relation to the existant ones in the market and also due to the advantage of the great sound absorption of the materials with which they are made (lightened plaster).